Table 2.4-1
Initial Screening of Remedial Technologies and Process Options
Portland Harbor Superfund Site
Portland, Oregon

General Response Action	Technology Type	Process Options	Description	Screening Comments
No Action	None	Not Applicable	Under No Action, no active remediation of any kind is implemented. The No Action response serves as a baseline against which the performance of other remedial alternatives may be compared. The NCP requires that No Action be considered as a potential remedial action in a feasibility study. Under the No Action alternative in the Study Area, contaminated river sediments would be left in place, without treatment or containment.	Required for consideration by NCP.
Institutional Controls	Governmental Controls	Commercial Fishing Bans	Commercial fishing bans are government controls that ban commercial fishing for specific species or sizes of fish or shellfish and are established by state departments of health or other governmental entities.	Retained site-wide.
		Waterway Use Restrictions or Regulated Navigation Areas	Provides notice to navigation to prevent damage to caps, in-situ treatment, EMNR, etc.	Retained site-wide.
	Proprietary Controls	Land Use/Access Restrictions	Restrictions, such as deed restrictions, easements, and covenants, placed in property related documents or physical barriers, such as fences.	Retained site-wide.
		Structure Mainenance Agreements	Requirements to conduct maintenance of in-water structures where caps or burried contamination are co-located in river.	Retained site-wide.
	Enforcement and Permit Tools	Permit Processes or Provisions of Administrative Orders or Consent Decrees	Legal tools, such as administrative orders, permits, and Consent Decrees (CDs), that limit certain site activities or require the performance of specific activities (e.g., to monitor and report on an IC's effectiveness). They may be issued unilaterally or negotiated.	Retained site-wide.
	Informational devices	Isolation Barriers	Construction fencing, geofabric, or other devise to prevent human interference with isolated contamination.	Retained site-wide.
		Fish Consumption Advisories	Fish consumption advisories provide information to the public from state departments of health or other governmental entities on acceptable fish consumption rates and fish preparation techniques.	Retained site-wide.
Monitored Natural Recovery	Physical Transport	Desorption, dispersion, diffusion, dilution, volatilation, resuspension, and transport.	Natural ongoing processes that reduce toxicity through transformation or reduce bioavailability through increased sorption, destruction, or reduction of bioavailability or toxicity of contaminants in sediment.	Retained site-wide.
	Chemical and Biological Degradation	Dechlorination (aerobic and anaerobic), bioderadation	Natural ongoing processes that dechlorinate or degrade chemical toxicity through biological processes.	Retained site-wide.
	Physical Burrial Process	Sedimentation	Reduce exposure through natural burial or mixing-in-place.	Retained site-wide.
Enhanced Monitored Recovery	Enhanced Burrial/Dilution	Thin Layer Cap	Enhancement of MNR (e.g., burial) through placement of a thin layer of material (e.g., 6" of sand).	Retained site-wide.
Containment in Place	Capping	Engineered Cap	Physical isolation of contaminants with sand cover.	Retained site-wide. Retained site-wide.
		Armored Cap	Physical isolation of contaminants with sand cover and other structural elements (such as armor) as necessary to keep the cap stable.	Retained site-wide.
		Clay Cap	Physical isolation of contaminantswith clay aggregate materials (e.g. , AquaBlok™) consisting of a gravel/rock core covered by a layer of clay mixed with polymers that expand in water decreasing the material's permeability.	Retained site-wide.
		Composite Cap (e.g., HDPE, Geotextile)	Physical and/or chemical isolation of contaminants by layering heavy-duty composite protection mat designed for placement over sediments to guard against damage by erosion, scouring, heavy equipment or other forces.	Retained site-wide.
		Reactive Cap	Placement of active capping layers such as activated carbon or organoclay to reduce contaminant flux through capping materials. Same technology as described above for other cap process options, depending on environmental conditions.	Retained site-wide. Limited to areas where contaminanted groundwater plumes or leachable contaminants are present.
		Slurry Bioremediation	Addition of nutrients and other amendments to enhance bioremediation	

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In-Situ Treatment	Biological Treatment	Phytoremediation	Use of plants to remediate contaminated sediments	Screened out site-wide since it is not considered feasible to implement in-situ biological treatment on contaminants are either not biodegradable (particularly heavy metals) or are very persistent in the environment (e.g. , PCDD/F, PCB, pesticides).
		Aerobic Biodegradation	Bioremediation uses microorganisms to degrade organic contaminants in soil, sludge, and solids in situ. The microorganisms break down contaminants by using them as a food source or cometabolizing them with a food source. Aerobic processes require an oxygen source, and the end products typically are carbon dioxide and water.	
		Anaerobic Biodegradation	Bioremediation uses microorganisms to degrade organic contaminants in soil, sludge, and solids either excavated or in situ. The microorganisms break down contaminants by using them as a food source or cometabolizing them with a food source. Anaerobic processes are conducted in the absence of oxygen, and the end products can include methane, hydrogen gas, sulfide, elemental sulfur, and dinitrogen gas.	
		Imbiber Beads	Spherical plastic particles that absorb a very broad cross section of the organic chemical spectrum.	
	Chemical	Chemical Slurry Oxidation	Application of chemical oxidants to remediate contaminated sediments. Chemical oxidation typically involves reduction/oxidation (redox) reactions that chemically convert hazardous contaminants to nonhazardous or less toxic compounds that are more stable, less mobile, or inert.	Screened out site-wide. There are no known sediment applications of in-situ chemical treatment involving the injection and subsequent removal of chemical reagents to demonstrate effectiveness and implementability of forming less toxic by-products on a large scale.
	Physical - Immobilization	Solidification/Stabilization	In-situ immobilization methods typically involve amending sediments in place with reagents, such as cement, quicklime, grout, or pozzolanic materials, that immobilize and/or bind contaminants to the sediment in a solid matrix or chemically stable form. These agents are mixed through the zone of contamination using conventional excavation equipment or a specially designed injection apparatus.	Retained site-wide. Limited to areas where access and slope stability issues exist (e.g., contaminated banks behind major structures with limited access).
		Sequestration	Sequestration is an innovative in-situ technology that involves the use of remedial agents like activated carbon, organoclays, apatite, and zeolites to reduce the toxicity, bioavailability and mobility of sediment contaminants. These agents are mixed into the sediment surface layer typically by mechanical means. SediMiteTM is a low impact system for delivery of remedial agents to the sediment surface. It is an agglomerate comprised of a treatment agent like activated carbon, a weighting agent, and an inert binder. The weighting agent enables the SediMiteTM granular material to sink to the surface and release the activated carbon which is then mixed by bioturbation.	Retained site-wide in areas subject to EMNR.
		Ground Freezing	The ground freezing process converts in situ pore water to ice through the circulation of a chilled liquid via a system of small-diameter pipes placed in drilled holes. The ice acts to fuse the soil or rock particles together, creating a frozen mass of improved compressive strength and impermeability. Brine is the typical cooling agent, although liquid nitrogen can be used in emergency situations or where the freeze is only required to be maintained for a few days.	Screened out site-wide.
Sediment/Soil Removal	Excavation	Dry Excavation	Use of excavators, buckets, etc. deployed from land based equipment. Can be "in the wet" or "in the dry" in combination with sheet piles, coffer dams, or other measures to remove water.	Retained site-wide for consideration in nearshore areas.
	Dredging	Mechanical Dredging	Use of clamshell, closed, hydraulic, or other buckets to remove contaminated sediment from a barge or other vessels.	Retained site-wide.
		Hydraulic Dredging	Use of hydraulic dredges (e.g., cutterhead, horizontal auger, plain suction, pneumatic, or specialty dredges) with various cutter and suction heads to remove contaminated sediments from the environment in a slurry phase.	Retained site-wide.
		Small Scale Dredge Equipment	Diver assisted or hand held hydraulic dredging, Mud Cat, and similar small scale removal methods.	Retained site-wide for consideration around structures.
	Commercial Landfill	Hillsboro	A disposal site where solid waste is buried between layers of dirt and other materials in such a way as to reduce contamination of the surrounding land. Modern landfills are often lined with layers of absorbent material and sheets of plastic to keep pollutants from leaking into the soil and water.	Retained site-wide.
		Northern Wasco County		Retained site-wide.
		Roosevelt Regional		Retained site-wide.
		Columbia Ridge (Subtitle D)		Retained site-wide.

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Disposal		Chem Waste (Subtitle C)		Retained for consideration for RCRA contaiminated waste.
	Onsite Upland Landfill	No likely candidate property.	A disposal site where solid waste is buried between layers of dirt and other materials in such a way as to reduce contamination of the surrounding land. Modern landfills are often lined with layers of absorbent material and sheets of plastic to keep pollutants from leaking into the soil and water.	Screened out site-wide due to lack of location and floodplain issues.
	Confined Aquatic Disposal (CAD)	Willamette River (RM 4/5)	Dredged material deposited in depressions or excavated pits or placed behind subaqueous lateral berms (at a nearshore location) followed by subaqueous covering or capping. If an engineered cap is used in conjunction with CAD at the disposal site, the potential need for armor in erosive areas must be evaluated, and cap maintenance would be required to ensure longterm chemical isolation of the disposed material. The final grade of a capped CAD cell would be similar to the adjacent subaqueous surface elevation.	Screened out due to interference with Federal Navigation use. See Table 2.4-3
		Willamette River (RM 9)		Screened out due to interference with Federal Navigation use. See Table 2.4-3
		Swan Island Lagoon (RM 8)		Screened out due to current and reasonably likely future uses and requires permanent institutional controls (e.g., deed restrictions, dredging moratorium) that may affect future development and uses of Swan Island Lagoon See Table 2.4-3
		Columbia River (RM 102.5)		Retained site-wide.
		Ross Island (RM 15)		Retained site-wide.
	Confined Disposal Facility (CDF)	Terminal 4 Slip 1	A CDF may be constructed as an in-water site (i.e., a containment island). An in-water CDF can be constructed with dikes or other containment structures to contain the contaminated dredged material, isolating it from the surrounding environment. The in-water CDF ultimately converts open water to dry land. A CDF may also be constructed as a nearshore site (i.e., in water with one or more sides adjacent to land). The Nearshore CDF converts open water to dry land. In some cases, a Nearshore CDF can be integrated with site reuse plans to both reduce environmental risk and simultaneously foster redevelopment in urban areas and brownfields sites (USEPA, 2005).	Retained site-wide. Excludes RCRA contaminated waste.
		Swan Island Lagoon		Retained site-wide. Excludes RCRA contaminated waste.
		Arkema		Retained for Arkema. Excludes RCRA contaminated waste.
	Physical	Particle Separation	Contaminated fractions of solids are concentrated through gravity, magnetic, or sieving separation processes.	Retained site-wide.
		Cement Solidification/Stabilization	The mobility of contaminants in sediments is reduced through addition of Portland cement.	Retained site-wide.
		Sorbent Clay Solidification/Stabilization	The mobility of contaminants in sediments is reduced through addition of sorbent clays such as bentonite.	Retained site-wide.
	Biological	Land Farming/Composting	Sediment is mixed with amendments and placed on a treatment area that typically includes leachate collection. The soil and amendments are mixed using conventional tilling equipment or other means to provide aeration. Moisture, heat, nutrients, oxygen, and pH can be controlled to enhance biodegradation. Other organic amendments such as wood chips, potato waste, or alfalfa are added to composting systems.	Retained for areas with only petroleum hydrocarbons.
		Biopiles	Large scale land treatment of petroleum hydrocarbons to reduce contaminant concentrations through biodegradation in biocells, bioheaps, biomounds, and compost piles. This is an aerated static pile composting process in which compost is formed into piles and aerated with blowers or vacuum pumps. Moisture, heat, nutrients, oxygen, and pH can be controlled to enhance biodegradation.	Retained for areas with only petroleum hydrocarbons.
		Fungal Biodegradation	Large scale land treatment to reduce organic contaminant concentrations by using fungal lignin-degrading or wood-rotting enzyme systems (example: white rot fungus).	Retained site-wide.
		Slurry-phase Treatment	An aqueous slurry is created by combining sediment with water and other additives. The slurry is mixed to keep solids suspended and microorganisms in contact with the contaminants. Upon completion of the process, the slurry is dewatered and the treated sediment is removed for disposal (example: sequential anaerobic/aerobic slurry-phase bioreactors).	Retained site-wide.

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Ex-Situ Treatment		Enhanced Biodegradation	Acceleration of the natural bioremediation processes by adding oxygen, reducing agents, nutrients, and degrading microrganisms to the sediment to improve the rate of natural biodegradation. Use of heat to break carbon-halogen bonds and to volatilize light organic compounds (example: D-Plus [Sinre/DRAT]).	Retained site-wide.
	Chemical	Acid Extraction	Use of acids to extract contaminants from dredged sediments. Suitable for sediments contaminated with metals, but not applicable to PCBs or SVOCs. No data on TBT.	Eliminated.
		Solvent Extraction	Use of solvents to extract contaminants from dredged sediments.	Retained sitie-wide for consideration for sediments contaning total PCBs greater than 50 ppm.
	Physical/Chemical	Sediment Washing	A physio-chemical process that uses impact forces in conjunction with chemicals to desorb contaminants from solid sediment particles of all sizes. During this process, contaminants are extracted and concentrated into the sludge associated with water treatment. Depending on the reagents used, in some instances, contaminants may be oxidized.	Eliminated.
		Chemical Oxidation/Reduction	Reducing/oxidizing agents are used to chemically convert toxic contaminants in excavated waste materials to less toxic compounds that are more stable, less mobile, and/or inert. Commonly used reducing/oxidizing agents are ozone, hydrogen peroxide, hypochlorites, chlorine, and chlorine dioxide. Target contaminant group for chemical redox is inorganics. Less effective for nonhalogenated VOCs, SVOCs, fuel hydrocarbons, and pesticides. Not cost-effective for high contaminant concentrations because of large amounts of oxidizing agent required.	Eliminated.
		Dehalogenation	Removal of halogens (e.g., chlorine) through chemical dehalogenation reactions. In the dehalogenation process, sediment are screened, processed with a crusher and pug mill, and mixed with sodium bicarbonate (base catalyzed decomposition) or potassium polyethylene glycol. The mixture is heated to above 630 °F in a rotary reactor to decompose and volatilize contaminants. Process produces biphenyls, olefins, and sodium chloride. PCB and dioxin-specific technology. Generates secondary waste streams of air, water, and sludge. Similar to thermal desorption, but more expensive. Solids content above 80% is preferred. Technology is not applicable to metals.	Eliminated.
		Radiolytic Dechlorination	Radiolytic (electron beam) and photolytic (ultraviolet, UV) dechlorination of polychlorinated biphenyls (PCBs). Sediment is placed in alkaline isopropanol solution and gamma irradiated. Products of this dechlorination process are biphenyl, acetone, and inorganic chloride. Process must be carried out under inert atmosphere. Only bench-scale testing has been performed. Difficult and expensive to create inert atmosphere for full-scale project.	Eliminated.
	Thermal	Incineration	Temperatures greater than 1,400°F are used to volatilize and combust organic contaminants. Commercial incinerator designs are rotary kilns equipped with an afterburner, a quench, and an air pollution control system.	Retained for RCRA-listed waste prior to land disposal of treated residuals.
		Pyrolysis	Chemical decomposition induced in organic materials by heat in the absence of oxygen. Pyrolysis typically occurs under pressure and at operating temperatures above 430ºC (800ºF). High moisture content increases treatment cost. Generates air and coke waste streams. Target contaminant groups are SVOCs and pesticides. It is not effective in either destroying or physically separating inorganics from the contaminated medium.	Eliminated.
		High Temperature Thermal Desorption	Heating of contaminated sediment to drive off and capture contaminants. Involves the application of heat (320 to 560ºC or 600 to 1,000ºF) to excavated wastes to volatilize organic contaminants and water. Typically, a carrier gas or vacuum system transports the volatilized water and organics to a treatment system, such as a thermal oxidation or recovery unit.	Retained for consideration for sediments contaning total PCBs greater than 50 ppm.
		Low Temperature Thermal Desorption	Involves the application of heat (90 to 320ºC or 200 to 600ºF) to excavated wastes to volatilize organic contaminants and water. Typically, a carrier gas or vacuum system transports the volatilized water and organics to a treatment system, such as a thermal oxidation or recovery unit.	Retained site-wide.

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		High Pressure Oxidation	This process includes two related technologies: wet air oxidation and supercritical water oxidation. Both technologies use the combination of high temperature and pressure to break down organic compounds. Predominantly for aqueous-phase contaminants. Wet air oxidation is a commercially-proven technology for municipal wastewater sludges and destruction of PCBs is poor. Supercritical water oxidation has demonstrated success for PCB destruction.	Eliminated.
		Vitrification	Vitrification is a process in which higher temperatures (2,500°F to 3,000°F) are used to destroy organic chemicals by melting the contaminated dredged material to form a glass aggregate product. The glass aggregates can be used for beneficial use products such as hot mix asphalt, construction fill, cement substitutes and ceramic floor tiles. Vitrification has been demonstrated to be very effective in destroying organic contaminants such as PCDD/F, PCBs, and PAHs in dredged material.	Retained site-wide.